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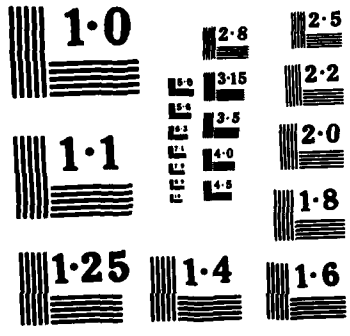

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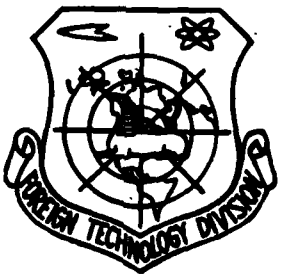
FOREIGN TECHNOLOGY DIVISION

NEW METHOD OF DETERMINING THE CURRENT CARRIER CONCENTRATION IN A SUBSTANCE IN THE STATE OF SUPERCONDUCTIVITY

by

F.P. Golotyuk



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NEW METHOD OF DETERMINING THE CURRENT CARRIER CONCENTRATION IN A SUBSTANCE IN THE STATE OF SUPER-CONDUCTIVITY

By: F.P. Golotyuk

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PREPARED BY:

TRANSLATION DIVISION
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WP-AFB, OHIO.

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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NEW METHOD OF DETERMINING THE CURRENT CARRIER CONCENTRATION IN A SUBSTANCE IN THE STATE OF SUPERCONDUCTIVITY

F. P. Golotyuk

This report proposes a fundamentally new solution to the problem of determining the current carrier concentration in a substance. The basis of the corresponding experimental method is a theory which considers the electron drift energy when considering the oscillatory processes in certain circuits [1].

We will consider a circuit in which external voltage which varies according to the law $U = U_m \cos \omega t$ acts.

When considering the drift energy of the current carriers [1], the differential equation which describes the oscillatory process in a circuit with elements R, L, C has the form:

$$\frac{d^2q}{dt^2} + 2\delta \frac{dq}{dt} + \omega_0^2 q = U_m \cos \omega t. \qquad (1)$$

Here q is the charge on the capacitor plates, U_m is the amplitude of the applied voltage,

$$\delta = \frac{R}{2L(1+\lambda)}, \qquad \omega_0 = \frac{1}{L(1+\lambda)C}. \qquad (2)$$

λ in formula (2) is equal to the ratio of the carrier drift energy

to the magnetic field energy of the latter, and it is determined by the expression [1]

$$\lambda = \frac{ml}{Ln_0 q_0^2 S} = \frac{mR}{Ln_0 q_0^2 \rho}, \qquad (3)$$

where m, q_0 and n_0 are the mass, charge and concentration of current carriers in the conductor from which the inductance is made; l, S and ρ are the length, cross section and specific electric resistance of the conductor. The solution of equation (1) makes it possible to obtain the relationship

$$U_{c,m} = \frac{U_m}{\omega C \sqrt{R^2 + \left[\omega L(1+\lambda) - \frac{1}{\omega C}\right]^2}}, \qquad (4)$$

in which $U_{c,m} = \frac{q_m}{C}$ is the amplitude value of the voltage on the capacitor; q_m is the maximum charge on its plates.

If we make the inductance of the circuit from the conductor considered above in the form of a solenoid with a double-wound winding, the self inductance coefficient $L \approx 0$. Then, introducing the designation

$$\tau = \lambda L = \frac{ml}{n_0 q_0^2 S} = \frac{mR}{n_0 q_0^2 \rho} \qquad (5)$$

and changing to the effective voltage values

$$U_{c,m}^{(эф)} = \frac{U_{c,m}}{\sqrt{2}}, \qquad U_m^{(эф)} = \frac{U_m}{\sqrt{2}},$$

we will rewrite relationship (4) in the form

$$U_{c,m}^{(эф)} = \frac{U_m^{(эф)}}{\omega C \sqrt{R^2 + \left(\omega\tau - \frac{1}{\omega C}\right)^2}}. \qquad (6)$$

Knowing the frequency ω, the voltage acting in the circuit, the capacitance, and the ohmic resistance of the circuit, and using a vacuum tube voltmeter to determine the voltages $U_{c,m}^{(эф)}$ and $U_m^{(эф)}$,

from formula (6) we can determine the value of γ, after which we find the current carrier concentration from expression (5). Obviously, the value of γ found from formula (6) will considerably exceed the error of measurement when the following conditions are satisfied

$$\omega\gamma \gg \frac{1}{\omega_0 C}, \tag{7}$$

$$\omega\gamma - \frac{1}{\omega C} \gg R. \tag{8}$$

As an example, we will consider the possibility of realizing conditions (7) and (8). Assuming that the solenoid is made from copper wire of length l - 1000 m, with a cross section $S = 10^{-8}$ m^2 and $n_0 = 10^{29}$ m^{-3} (there is one free electron per atom in the calculation), from formula (5) we obtain $\gamma = 5 \cdot 10^{-11}$ H. With a voltage frequency of $f = \frac{\omega}{2\pi} = 100$ mHz and a capacitor capacitance of 10^{-4} F, $\frac{1}{\omega C} = \frac{1}{100}\omega\gamma$, so that condition (7) can actually be satisfied. Considering that $\frac{1}{\omega C} \ll \gamma\omega$, and also relationship (5), we will rewrite condition (8) in the form

$$\omega \gg \frac{R}{\gamma} = \frac{n_0 q_0^2 \rho}{m}. \tag{9}$$

In our case, the numerical calculation gives us $\omega \gg 4 \cdot 10^{19}$ Hz; therefore, condition (9) cannot be realized. Since all metals have similar values of n_0 and ρ, if the solenoid is made from other metal conductors, the value of ω will be around 10^{19} Hz and it also is impossible to satisfy condition (9). But when the conductor is in the state of superconductivity (R = 0), condition (9) is satisfied.

Thus, the method in question of determining the current carrier concentration in a substance is appropriate when this substance is in the superconducting state.

REFERENCES

1. F. P. Golotyuk. Problem of considering the kinetic energy of directed movement of current carriers. See article in this collection.

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